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Assessing the design of China's complex health system – Concerns on equity and efficiency



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ABSTRACT

Following the global trend of moving towards Universal Health Coverage, China has implemented a new round of health system reform, to achieve universal “safe, effective and affordable basic healthcare services” by 2020. We review the latest reforms using the World Health Organization framework developed by Murray and Frenk. In particular, we diagrammatically describe the structure of the current Chinese health system using the dimensions of *Stewardship*, *Resource Generation*, *Financing and Provision*, and assess the variability of access, levels of benefits, and quality of service across populations. We identified several areas of inequity and inefficiency. First, the fragmented institutional arrangements, with distinct objectives and responsibilities across agencies, create potential nonalignment of incentives. Second, there is a marked scarcity of qualified general practitioners and infrastructures despite the continuing effort to improve the gatekeeping function of primary care providers. Third, as risks are pooled only at the local level within different insurance schemes, the considerable income heterogeneity across geographic territories and resident types can generate significant inequality in access and funding. Fourth, persistent patient preference for higher quality healthcare at hospitals prevents the integration of care across tiers. We believe our comprehensive analysis will be informative for both health policymakers and researchers, in identifying and investigating the inefficiencies of the health system and the potentials for structural integration to achieve healthcare equity.

1. Introduction

Following the global trend of moving towards Universal Health Coverage (UHC), China implemented a new round of health system reform in 2009 to achieve universal “safe, effective and affordable basic healthcare services” by 2020 [1]. The primary objectives of the reform included developing primary healthcare services and providing equal access to urban and rural residents. Since 2017, the deepening of the healthcare reforms has been accompanied by a “Healthy China Strategy”, where new directives were introduced to provide more well-rounded and full-cycle health services. While the reform has been rolled out gradually over the years, access to healthcare and the distribution of the benefits have not been straightforward [2]. The process was further complicated by increasing income inequality, an ageing population, low fertility rates, and most recently by the COVID-19 crisis.

As one of the most rapidly changing and comprehensive efforts undertaken by a health system in the world, China's healthcare reforms warrant an extensive examination of the various dimensions of its changing health system. A necessary first step is to unravel and understand the complexities of the Chinese health system; to this end, we undertake the first assessment of China's health system, using the World Health Organization (WHO) framework developed by Murray and Frenk [3]. Our approach is similar to the assessment of the healthcare systems in Ghana and Nigeria when moving towards UHC [4]. In particular, we diagrammatically describe the structure of the current Chinese health system using the four functions of *Stewardship*, *Resource Generation*, *Financing and Provision*, and we analyse the variability of access, levels of benefits, and provision across populations. The strength of our work relies on generating, for the first time to our knowledge, a diagrammatic overview of China's health system, which shows the degree of fragmentation, both horizontal and

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vertical, of the functions mentioned above. An overview of the potential impact on equity and efficiency of the different dimensions of the healthcare system complements the detailed analysis and descriptions of the four functions.

1.1. Background of China's healthcare reform

Major reforms have taken place in China to address the persistent challenges due to the inconsistencies in healthcare provision, unequal access, surges in healthcare costs and the burden of chronic illness arisen from previous reforms towards marketisation. A description of key facts about China's healthcare system can be found in the [Appendix](#). In 2009, the government set objectives to increase universal coverage, develop a functioning primary healthcare service that was previously abolished, ensure equal access for urban and rural residents, and to improve public hospitals' operating environment [1]. The timeline of the critical events can be found in [Fig. 1](#). Among the different objectives, three specific reforms constitute the current focus of the healthcare system design.

Before 2015, the primary care system did not operate under a patient referral network, resulting in extremely overcrowded hospitals in major cities. In 2015, a general practitioner referral system was introduced nationally to improve accessibility and reduce inappropriate use of higher-tier hospital care. To incentive primary healthcare facility use and divert patient from large hospitals, a higher reimbursement rate has been set for the former. However, the uptake of the referral system has been meagre because of the persistent patient preference for hospital-based services, even for minor issues [5,6]. Further, hospitals are heading medical alliances, in the form of networks, to train lower-level facilities to improve their perceived lower quality of care.

Another policy issue was the multitude of medical insurance schemes as well as the various ministries and agencies involved in the insurance schemes, which have negatively affected the efficiency of the system. As a result, an important reform was introduced in 2018 to merge the New Cooperative Medical Scheme (NCMS) for rural residents and the Urban Resident Basic Medical Insurance (URBMI) for urban residents. Despite elevating the coverage of NCMS to URBMI standards, migrant workers are still not fully protected by the current set-up, as they remain insured in their province of origin. This often translates in lower access to healthcare services, when needed, or in foregoing healthcare altogether. The main reason is that reimbursement for their cross-province medical expenses needs to be sought in the migrants' province of origin, which is hindered by considerable travel distances and associated costs [7].

Since public hospitals are financed through government subsidies, service charges and mark-ups on drug prices, such structure inevitably created distorted incentives to prescribe higher volume and more expensive drugs than necessary to earn additional bonuses. Public hospitals had no incentive to contain cost, thereby dramatically boosted healthcare expenditure. In 2012, alongside the zero-mark-up drug pol-

icy, public hospitals had been asked to become more independent in running their daily activities [8]. The most recent approach, called "Modern Hospital Administration System", evaluates hospital directors' performance on clearly defined indicators, such as patient volume and satisfaction, and the level of expenditure, thus realising a more evidence-based approach [9]. The new approach also aims at decreasing out-of-pocket expenditure and hospital length-of-stay [10,11].

Given the rapidity and the complexity of the various reform waves, one may quickly lose sight of the fundamental building blocks of the system and the roles they play in facilitating or hindering the implementation of the reforms. In what follows, we systematically assess the design of the current healthcare design and its implications on equity and efficiency.

2. The building blocks of China's health system

Murray and Frenk [3] recommended that "any systematic attempt to understand the performance of health systems should include a study of factors that potentially explain it" [3]. They did so by outlining and defining the functions or institutional arrangements that are present in any health system: *Stewardship, Resource Generation, Financing and Provision*, within a new framework. We chose to employ the WHO framework, developed by Murray and Frenk, because it offered a coherent and consistent approach in identifying a health system's intrinsic goals, its key functions and how these interact and influence the overall performance of a health system. Hereafter, we describe these functions for China's health system and discuss the intermediate outcomes of the current design in terms of efficiency and equity.

2.1. Stewardship

The Stewardship function permeates and shapes the entirety of a health system, i.e. financing, provision and resource allocation. Murray and Frenk [3] describe it as comprising three key aspects: (i) setting, implementing and monitoring the rules for the health system; (ii) assuring a level playing field for all actors in the system, i.e. purchasers, providers and patients; and (iii) defining the strategic direction for the health system as a whole.

In China, several stakeholders, operating at different government levels, are responsible for various "Stewardship" functions. [Fig. 2](#) provides a visual aid of the different organisations/institutions at play.

China's health administration has a four-level hierarchical structure. The National Health Commission (NHC, previously the National Health and Family Planning Commission and the Ministry of Health) is at the top, followed by provincial health commissions, responsible for organising and supervising providers. Below these institutions are prefecture/municipal-level health commissions that draft local regulations and coordinate resource allocations; and, at the bottom, are county/district health commissions, which enjoy slight flexibility in implementing provincial health policies. No independent health administration exists at the township level, with providers directly under the county health commission's supervision.

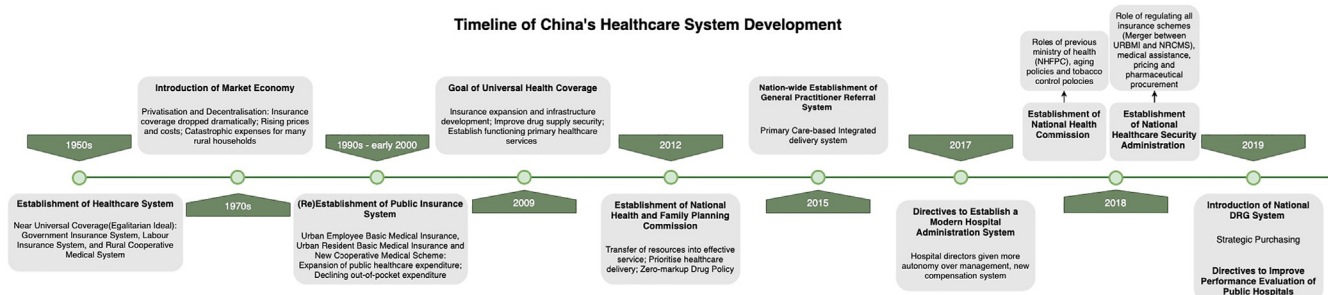


Fig. 1. Timeline of healthcare reforms in China.

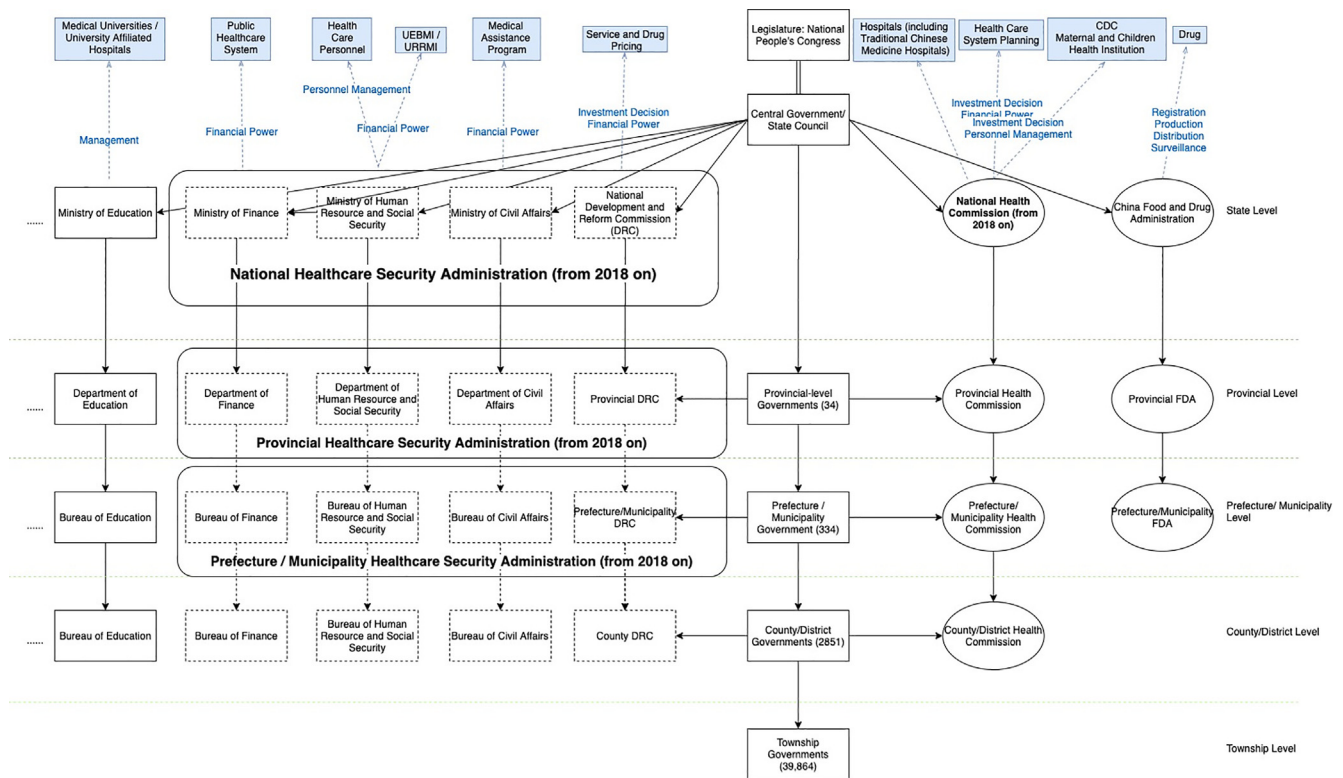


Fig. 2. Stewardship function.

The majority of the health legislation are administrative laws issued by the Standing Committee of the National People's Congress; administrative regulations promulgated by the State Council; and local laws and regulations issued by ministries or local governments [12]. The NHC drafts five-year plans that include the budgets and competition policies among healthcare providers [13,14]. The newly established National Healthcare Security Administration (NHS) assumes the previous roles of the Ministry of Civil Affairs, the Ministry of Health and the Ministry of Human Resources and Social Security. Specifically, the NHS manages all the public medical insurance programs and healthcare personnel, sets prices for essential medicines, maintains the safety net (e.g. healthcare access) for the poor in rural areas. The Ministry of Education oversees medical schools, and the Ministry of Finance produces annual budgets and subsidies and monitors the financial performance of central government spending based on the five-year plans. The Food and Drug Administration ensures safety for drugs and medical devices. Finally, the Bureau of Health Politics and Hospital Administration, which operates within the NHC, has the responsibility for assessing and monitoring the quality of healthcare provided [14]. However, there is still limited systematic evidence on process and outcome measures of quality [9].

The sheer number of independent governmental organisations with different remits and strategic designs, each carrying out some form of stewardship function, shows how complex, fragmented and potentially inefficient the health system governance is in China. Different ministries often have conflicting interests and, therefore, do not collaborate proactively. For instance, hospital directors, by design, respond to multiple government agencies with different objectives at the local level. At the same time, hospital directors are rarely monitored for non-compliance and as a result, are not accountable for inefficiencies or low quality service [7]. Although the recent creation of the NHC and NHS have substantially reduced the organisational fragmentation, it is still challenging to assign clear accountability of the stewardship function, both to the governmental institutions issuing guidance

and regulations at the higher government tiers and to those that are tasked with implementing them at the middle and lower levels.

2.2. Resource generation

Resource generation entails all the organisations that govern, produce, and deliver the inputs to health systems. Unlike the financing function, resource generation involves a wide range of institutions that are not strictly or directly related to healthcare delivery. The most critical dimension is human resources, while physical resources such as buildings, equipment and technology, pharmaceuticals, and overall knowledge are also part of this function.

The human capital of China's health sector includes medical staff, nurses and healthcare professionals working in hospitals, primary healthcare institutions and public health agencies. While the number of physicians and medical staff is steadily rising, access to medical professionals was characterised by wide geographic disparities before 2009 [15,16]. The 2009 reform to achieve universal health coverage has gradually reduced the inequality of resource distribution in recent years, but the gap still exists [17]. By 2018, there were about 2.59 physicians per 1,000 population, ranging from 4.01 to 1.82 physicians, respectively, for urban residents and rural residents [18]. Imbalances in the absolute distribution of healthcare workforce across regions, and between urban and rural areas, represent a crucial barrier for the development of health services, especially in rural areas [19].

The highest level of education attained varies greatly across medical professionals: from postgraduate and undergraduate, to college/technical secondary school/high school and below. By law, a doctor is required to have graduated from a faculty of medicine with a license to practice [20], whereas in rural areas, village doctors have to pass only local exams to obtain a "Village Doctor Certification" [21]. Over the years, the number of medical professionals attaining the highest qualification has risen, with the proportion of bachelor's degree holders increasing from 17.1% in 2005 to 34.6% in 2018 [22]. However,

disparity persisted across urban and rural areas, especially in terms of the proportion of personnel that hold a bachelor's degree, or above, in primary healthcare institutions. Although the Ministry of Education oversees medical universities, many of the doctors in rural counties did not have a formal medical education and thus were not subject to the same level of standard medical training outlined by the ministry. For instance, only 6% of health workers in rural areas had a bachelor's degree [7]. The variability of the qualification across geographic areas consequently drove patients to travel to urban areas, in order to seek the best quality of healthcare possible, resulting in extremely overcrowded hospitals in big cities, as well as in long waiting times.

To ensure some basic level of gatekeeping, the 2009 healthcare reform introduced a family doctor and general practitioner (GP) referral system, implemented officially in 2015. However, there was no established education system for family medicine training, as historically universities only train specialists. A policy document suggested a potential change to the education system in order to train undergraduate students to become GPs in three-year programs, rather than the traditional “5 + 3” program for specialists [1]. Overall, the supply of GP and family doctors are still in their incipient stages, and the roles are quite different from those that exist in European countries. To improve the efficiency of primary healthcare delivery, the government implemented an integrated health information system to connect public hospitals and primary healthcare facilities with more ancillary Internet + health services [23]. However, the data governance remained fragmented as the NHC hosts the electronic health data and the NHSA hosts the insurance claim records, while each hospital also has a unique medical record system – none of the different sources is interoperable [24]. Therefore, integration of care requires a more effective electronic health system.

A resource unique to the Chinese health system is the Traditional Chinese Medicine (TCM) doctor. Typically, TCM doctor practices either in a TCM specialised hospital or the GP department in local community centres. During the COVID-19 outbreak, TCM played a significant role in effectively treating patients with highly tailored Chinese medicine [25]. Despite the widespread recognition of their importance, the trend to westernise TCM professional education may cause sharp contradictions between the training and the practice of TCM, which historically followed a rigorous apprenticeship tradition [26].

Similar to most countries, the physical resources in China's health system include hospitals of different tiers and specialisations, primary healthcare institutions, specialised public health institutions, and pharmacies. The number of hospitals and their capacity has been unequally distributed across geographic areas – the drastic economic development of the Eastern urban regions of China created a higher concentration of both general and specialised hospitals, for example [23]. This has resulted in the emergence of a peculiar pattern of healthcare use, with residents in more affluent areas overusing hospitals for outpatient care, and residents in more impoverished regions using primary care institutions for inpatient care [11]. The substantial disparity across local governments in terms of financial capability, operating efficiency, quality of care, and continuity of care from primary healthcare centres to tertiary hospitals remains a major challenge [2], despite the recent reforms to facilitate a patient referral network and to elevate insurance coverage of urban residents. This disparity highlights the urgency in accelerating the development of primary care infrastructures in urban regions and the investment of higher-tiered hospitals in the central and western regions. The current fragmentation in the government financing system and insurance arrangements needs to be tackled with urgency in order to (re-)distribute financial resources adequately and to redress horizontal resource disparity.

2.3. Financing

Whether it is a collective or a market-based system, the financing function in any health system can be divided into three distinct, but

closely interlinked functions: (1) revenue collection, (2) fund pooling and (3) purchasing. In what follows, we discuss the different functions and their potential implications on equity and efficiency, along with the diagrammatic representation of the overall financing structure of the health system.

2.3.1. Revenue collection and fund pooling

The Chinese healthcare financing system is a mix of public insurance models. The sources of total health expenditure are composed of government (central and local) taxation, social contributions, and out-of-pocket payments. However, the collection of revenues remains fragmented, as the pooling of funds and government finance does not go beyond the prefecture or municipality level.

Two primary public insurance schemes coexist to collect revenues (see Fig. 3): a mandatory public insurance for urban employees (cost-sharing with employers) – the Urban Employee Basic Medical Insurance (UEBMI), which covers around 300 million workers; and a voluntary public insurance for non-working urban and rural residents including students and children – the Urban-Rural Resident Medical Insurance (URRMI), which is a merger between the URBMI and the NCMS. The URRMI currently covers around 1 billion residents. In addition, there is a Medical Assistant Program (MAP), for those who are not enrolled in the other two schemes. Supplementary private health insurance exists to provide coverage for services not covered by public insurance. The benefits packages usually cover inpatient care and critical outpatient care, while catastrophic insurance schemes exist for specific diseases (e.g. cancer). There is patient cost-sharing, through both deductibles and co-payments, to reduce unnecessary utilisation of healthcare services and reduce the onset of moral hazard. All schemes have their distinct formulas for reimbursing drugs and services.

Within the UEBMI, separate sub-schemes exist to cater for specific types of employees: the “integrated social pooling and individual medical savings accounts (MSAs)” for formally employed full-time workers; the “solitary social pooling” for the ‘informally’ employed; and the “lower-level social pooling” for retirees. The sub-schemes differ in the way funds are raised and pooled, and in the type and amount of coverage offered. Premiums are collected through both employer and employee contributions (set respectively at 6% and 2% of an employee's salary). In the first sub-scheme, employee contributions are paid directly into their individual MSAs, while employer contributions are split between the integrated social pooling (around 70%) and the MSA (around 30%). Contributions in the “solitary social pooling” schemes are based on the average salary in the local area, while the contribution is even lower for the “lower-level social pooling”. In addition to the social pooling, the UEBMI also receives fixed contributions set by the central government. However, fund pooling within UEBMI schemes is horizontally and geographically fragmented, i.e. funds are pooled only within each sub-scheme at the municipality/prefecture level. The fragmentation might generate issues with both vertical and horizontal equity in financing, access to benefits packages, and in terms of co-payments imposed on enrollees. Furthermore, total revenues collected by the UEBMI sub-schemes may vary substantially, affecting both the depth and breadth of benefits packages and the pay-outs that insurance schemes can make. Recent studies have confirmed the imbalance between healthcare costs and choice of hospital types between socioeconomically developed and underdeveloped regions [27].

The newly integrated URRMI is funded primarily by central and local government subsidies, with minimal individual contributions and funds pooled at the prefecture/municipality level. There is integrated social pooling, but no MSAs. The merger of the previous urban and rural residence schemes has been carried out in a staggered way, with considerable variability in the extent of integration across geographic areas. Eight provinces only enrol resident individuals, while other provinces do not restrict coverage requirements; additionally,

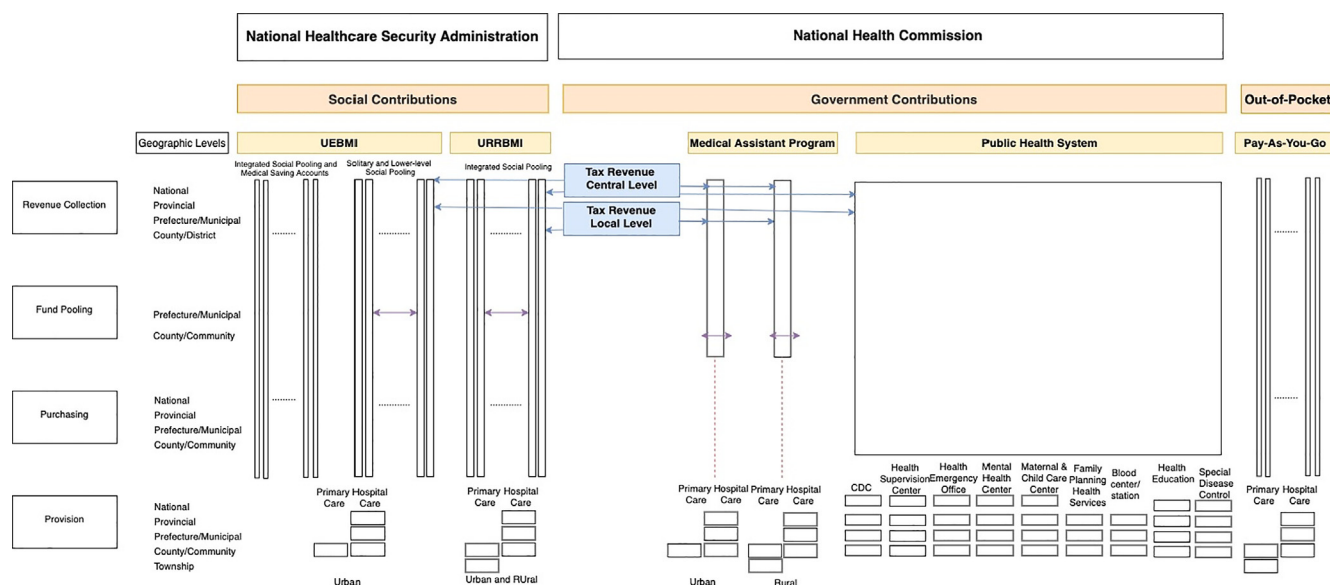


Fig. 3. China's healthcare system.

in Fujian and Guangdong provinces, there has been full integration across all three medical insurance schemes [28]. Since the revenue of URRMI depends mainly upon the financial capability of the local government, the benefit packages and co-payment schemes tend to differ from UEBMI and can vary substantially across geographic units [29].

Even with the two major insurance schemes, both rural and urban residents, may have been unable to pay for catastrophic healthcare expenses. For this reason, the MAP was in place, with free and voluntary enrolment. Initially only providing subsistence allowance to low-income elderly and disabled residents, the program now extends to fund comprehensive care for the poor. MAP is subsidised by the urban and rural medical assistance system. Differently from other insurance schemes, funds are pooled at the county level.

2.3.2. Purchasing

Purchasing refers to the process by which collected, pooled and possibly risk-adjusted funds are allocated to individual or institutional providers. This process relates to the what, how and from whom healthcare is purchased and whether or not mechanisms are put in place to preclude perverse and often inefficient incentives in healthcare providers. In the case of China, the purchasing authorities are highly fragmented and do not operate under a functioning strategic purchasing mechanism. The various social insurance schemes were previously managed independently by two different ministries, without any strategic interaction. In 2018, the NHSA was established to improve the governance of social insurance programs and change the ways providers were paid.

Since its establishment, the NHSA has developed the organisational capacity and improved existing purchasing mechanisms. In the last two years, the NHSA has set in place effective negotiations between purchasers, pharmaceutical companies, and hospitals. However, there is little evidence so far that the new purchasing mechanisms follow the national objectives set out in the "Healthy China Strategy".

The new administration is also in the process of implementing a provider payment reform. Traditionally, China's hospital care has been reimbursed through a fee-for-service reimbursement system. There was, therefore, a need to set appropriate reimbursement rates/mechanisms for providers. Since the late 1990s, various forms of prospective payment methods have been piloted to modify healthcare providers' incentives, while the first version of Diagnosis Related Group (DRG)

was established in the 1980s. In 2017, the State Council issued a new policy, which resulted in around 30 cities implementing the DRG system by 2018 [30]. However, the DRG system implemented in China is still rudimentary and in an early adoption phase. Many different forms of (prospective) payment systems are still widely used, despite recommendations for uniform dissemination [31].

Additional to payments received from social insurance schemes, public hospitals also receive direct funding from governments at various tiers. The direct funding is in the form of global budgets, not tied to the needs of the facilities or the populations served, or linked to the performance of the hospitals [32]. They are usually determined by the size of the hospital and the local fiscal capacity, disjointed from incentives set in terms of quality of care or efficiency targets [33].

Despite recent efforts, China is still far from being able to implement strategic value-based purchasing.

2.4. Provision

Similar to other sectors of the economy, the provision of healthcare comprises the selection and combination of inputs that, through a production process, leads to the delivery of healthcare goods and services. In China, the NHC is in charge of the national health development planning and management of the healthcare system, while commissioners at the provincial, municipal and county levels are responsible for the delivery of healthcare services. The health delivery system is mixed, comprising both public and private providers. In 2012, there were 912,620 primary health centres (PHC) in China, 52% of which were public facilities, with the rest equally split between private for-profit and private not-for-profit [7]. Secondary and tertiary general hospitals provide most outpatient and inpatient services, and specialised hospitals provide mental, dental and oral health services [12]. In 2012, there were 23,170 hospitals in China, of which just under 58% were public, about 15% were private not-for-profit and just under 28% private for-profit [7]. Although hospitals have been increasingly endowed with more and more autonomy over their daily operations (traditionally operated under a "command and control" model), the government still exerts administrative power over several managerial aspects such as bed numbers and the appointment of key managers. As a result, public hospitals are accountable to the corresponding political authorities and are subject to several public organisations. This distorted version of a semi-autonomous model has been

regarded as one of the root causes for the inefficiencies in the delivery of healthcare.

Since 2006, a two-way patient referral regulation has been in place to promote the rational use of health services [12]. In principle, patients in urban areas should first seek medical services at a primary healthcare institution, from which they are then referred to secondary and tertiary hospitals. The ultimate aim is to integrate the three levels of healthcare provision fully. The rapid demographic and epidemiological changes, due to an ageing society and increasing burden of non-communicable diseases, reinforced the need to transform its hospital-centric and volume-driven system into an affordable, high-quality care system around the model of the patient-centred integrated care [7]. However, many of the factors mentioned elsewhere in this paper, such as the fragmented governance arrangement, the lack of qualified healthcare professionals and the variability of financing schemes, all pose significant barriers for the full integration across the different tiers. Finally, the integration process was further complicated by the existence of separate and independently managed organisations, loose definitions of provider function across tiers, as well as ambiguous referral criteria guidelines [7].

The COVID-19 outbreak emphasised the (mis-)functioning of the public health system in China. By design, primary healthcare institutions and specialised public health facilities assume the role of providing public health services, while some community health centres and village clinics offer complementary services such as disease management, rehabilitation, health education and family planning. Other highly-specialised public health institutions such as the Centre for Disease Control and Prevention, health education institutions, maternal and child health institutions and mental health institutions provide different kinds of professional public health services [23,12]. The NHC and the State Administration of Work Safety are responsible for occupational health, work safety, and launching relevant regulations [34]. Several departments within the NHC are in charge of the administration of public health, including the Disease Control Bureau, Health Supervision Bureau, Emergency Response Office, Primary Healthcare Department, Maternal and Child Health Department, and Food Safety and Supervision Department [12]. Local health bureaux at each level have also set up similar departments which are responsible for local public health management. As there is no single organisation that manages public health, the COVID-19 outbreak has highlighted the need to address current failures and shortcomings as urgency in the near future.

All institutions involved in service provision are shown in Fig. 3.

3. Discussion

To some extent, the experience of China's healthcare reforms has been unique, given its top-down approach of implementation, and the radical overthrow of existing policies and structure. On the other hand, the cycle of reforms has been driven by ideological changes, due to a change of leadership and the shifting of government's preferences between a government and a market-oriented health system. This process is not too different from many other high- and low-middle-income countries that have experienced various levels of centralisation, decentralisation and liberalisation [35]. Moreover, in China, reforms were often constrained/limited by the geographical size of the country and variation in terms of socio-economic development. This has led the central government to rely on extensive use of pilot programs, mostly run at the provincial level, to investigate the potential effects of new health policies before national roll-outs. The rationale behind this approach is to allow each province a higher level of discretion within their own jurisdictions when implementing centrally designed policies so that these can be tailored to local health needs and reflect local fiscal capacity. Consequently, the main factors influencing the adoption and implementation of these recent reforms

have been local pressures to respond to local governance problems, imitation of innovations adopted by peers, and regional preferences. This decentralised approach has resulted in significant variations at the local level. In more recent years under President Xi's leadership, China has been experiencing an increase re-centralisation of political power, which has meant a renewed expectation for centrally designed policies to be implemented 'as is' at the local level. Nonetheless, local governments can still choose from an array of models when implementing central policies.

What the Chinese lesson offers is a compelling case that involves the largest population experiencing a rapid change from a highly profit-driven and unequal healthcare system to, at least in principle, near-universal coverage [36], but with many of the historical problems still plaguing the system. However, the incredible efforts and momentum exerted by the government, and the firm will for the improvement of the population health, are commendable.

In our effort to systematically describe and assess China's current health system, we have identified several areas of concern. The geographic disparity is profound in terms of healthcare infrastructure and human resources between rural and urban area, and between the more affluent regions along the coast and more impoverished Western inland provinces. Moreover, because the social pooling of insurance funds is only carried out at the prefecture and municipality level, and within each scheme, the marked disparity across geography and individual residence status can generate significant inequality in total funds available as well as in the breadth and depth of benefits packages offered. This inequality is a consequence of considerable variations in the socio-economic development of the country, and which we believe requires concerted efforts by the central government to redistribute the necessary financial resources and healthcare workforce following the principle of both horizontal equity in access and vertical equity in financing. Even within economically advanced areas, a shortage of qualified primary healthcare practitioners and infrastructure contributed to the inexistent gatekeeping function of primary healthcare providers. Since patients persistently exhibited hospital-centric preferences when seeking healthcare, there was an intrinsic tension which prevents the intended integration of care across tiers. These challenges are interconnected and have not been sufficiently addressed by the fast-paced implementation of the reforms. Finally, the existence of multiple insurance schemes and funding pools highlights the inherent inefficiency of the overall system design, with obvious and often non-necessary duplication of cost functions. The absence of a well-developed and structured purchasing function, with reimbursement still often linked to historical expenditure or based on a fee-for-services system, is probably the source of recent escalating healthcare costs. The introduction of a nationally unified DRG-based reimbursement system might improve current inefficiencies, but only if specific financial and quality targets are concurrently introduced.

Our analysis of the four functions of the Chinese health system has brought to the fore a common thread: the enormous complexity of the four functions and the health system as a whole. There is a myriad of institutions, organisations and agencies, operating in a highly fragmented environment, both horizontally - across different ministries and department - and vertically - across the different level of governments. They often have conflicting and ill-defined remits, lacking common objectives and scopes, a clear set of incentives and accountabilities, and more importantly, strategic integration. This finding implies that sustainable and scalable reforms have been compromised, as agencies and ministries often act to defend their own interests, rather than working towards the achievement of the common good. The successful implementation of the health reforms in China may have been historically weakened by flawed decision-making processes which are too often, and sometimes exclusively, reliant on interagency bargaining [7].

Our descriptive analysis of the four functions of a healthcare system provides a valuable overview of the Chinese health system and has

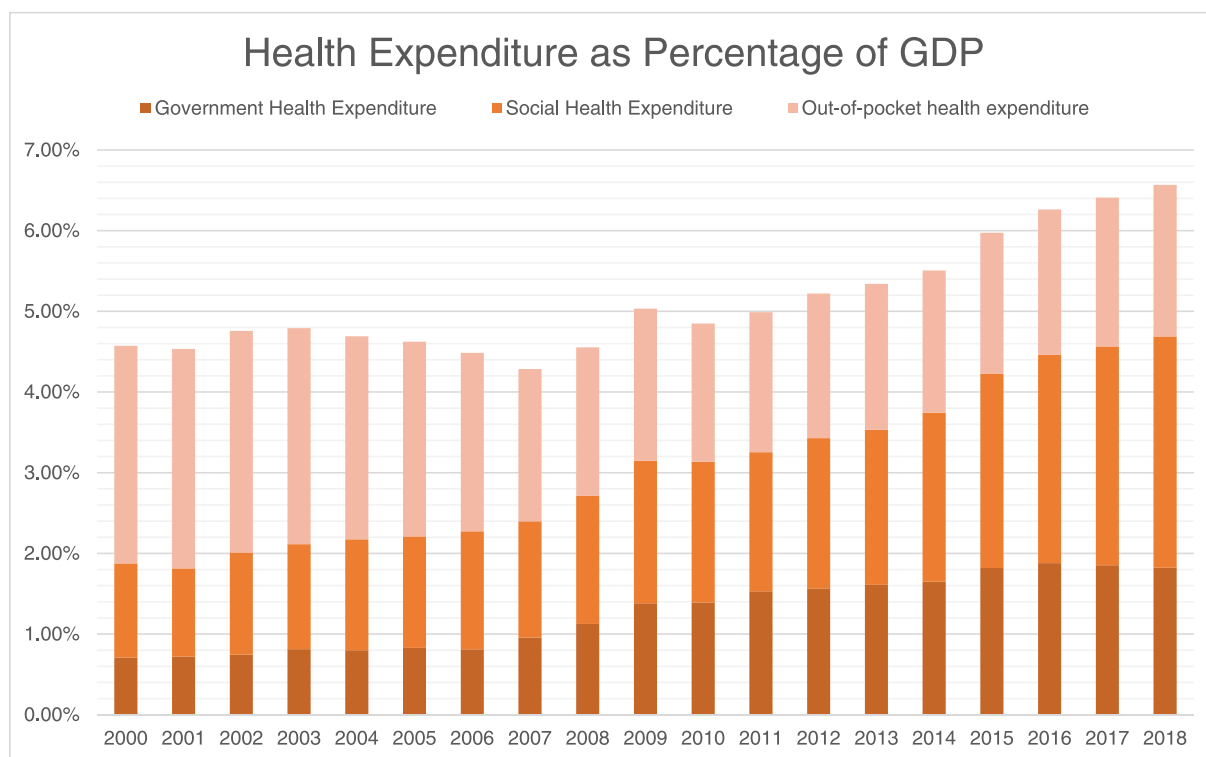


Fig. A1. Health expenditure composition, 2000–2018 (National Bureau of Statistics, China).

highlighted areas of its system design and reforms that warrant future assessments and evaluations. The latter cannot be carried out without a good understanding of the former, as Murray and Frenk originally suggested with their framework.

Authors' contributions

YW performed the descriptive and diagrammatic analysis of the different functions. AC contributed substantially to the conceptualization and analysis of the different functions. DL contributed to some sections of the analysis. QC provided the latest insights and controlled for the accuracy of all the policy reforms. All authors contributed to the interpretation, writing and editing of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

China has a vast territory, with 1.4 billion people, and is the world's second-largest economy by Gross Domestic Product (GDP) [37]. Since early 2000, health expenditure has been on the rise, with per capita expenditure at purchasing power parity reaching almost \$1,200 in

2016, compared to about \$200 in 2000 [37]. Though health expenditure as a proportion of GDP only increased from 4.5% to around 7% over the years (Fig. 1), the volume is considerably high given the drastic growth of the overall GDP. The burden of out-of-pocket expenditure as a proportion of total health expenditure declined over the years and flattened out at 29% by 2018. However, this is still relatively high compared to the OECD average of about 21% in the same year [38]. The composition of health expenditure has shifted dramatically, with government and social spending on the rise and out-of-pocket expense shrinking accordingly (Fig. A1). This trend is the result of the gradual expansion of the basic insurance coverage. Although the infant mortality rate dropped steadily over the same period [37], the challenges of sustaining the healthcare needs of China's population, and the persistent inequality of access, are yet to be resolved. An ageing society and rising chronic non-communicable diseases further hinder these challenges. The recent COVID-19 outbreak has placed the design of the public health system under scrutiny, as the lack of medical supplies, public health specialists and initial information transparency accentuated the issues of China's fragmented healthcare system.

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